CLAIMS

Sub A1

~~1. A method of processing data defining first polygons which approximate at least part of a curved three-dimensional surface to produce second polygons for use in rendering an image of the surface, the method including for each first polygon the steps of:~~

~~defining a respective surface patch to approximate the part of the object surface represented by the first polygon;~~

~~dividing the first polygon into a plurality of notional polygons; and~~

~~for each notional polygon, defining a said second polygon for rendering using the surface patch of the first polygon to determine the positions of the vertices of the second polygon in three dimensions.~~

2. A method according to claim 1, wherein the first polygons approximating the curved three-dimensional surface are triangular, and a Bernstein-Bezier triangular patch is defined as the surface patch for each first polygon.

3. A method according to claim 2, wherein a cubic Bernstein-Bezier triangular patch is defined for each

first polygon.

Sub A2

4. A method according to claim 1, wherein the step of defining a surface patch for a first polygon comprises calculating control values at control points for the first polygon to define the surface patch.

5. A method according to claim 4, wherein the control values for each vertex of the first polygon are set to zero.

6. A method according to claim 4, wherein the control values for control points along an edge other than vertices are calculated by determining the distance from the control point of the tangent plane at the nearest vertex in a predetermined direction.

7. A method according to claim 6, wherein the predetermined direction is based on the direction of the normal at the nearest vertex alone.

8. A method according to claim 6, wherein the predetermined direction is based on the normal at each vertex defining the ends of the edge on which the control point lies.

9. A method according to claim 1, wherein each surface patch is a Herron patch.

Sub A3

~~10. A method according to claim 1, wherein, in the step of dividing a first polygon into notional polygons, the division is performed in dependence upon at least one of the size of the first polygon in a previous frame of image data, the size of the first polygon in the current frame of image data, the curvature of the first polygon, the distance of the first polygon from the viewing position in a previous frame of image data, and the distance of the first polygon from the viewing position in the current frame of image data.~~

11. A method according to claim 1, wherein, each first polygon is divided into the same number of notional polygons.

12. A method according to claim 11, wherein the number of notional polygons is determined by testing each first polygon to determine a division number therefor defining a number of notional polygons, and selecting the highest division number.

13. A method according to claim 11, wherein:

processing is performed for each frame of image data to be generated to determine a level of subdivision defining the number of notional polygons into which each first polygon is to be divided;

data defining the second polygons produced for rendering is stored for future use when it is generated for a level of subdivision for which data is not already stored; and

the stored data is used when a frame of image data is to be generated for a level of subdivision for which data is already stored.

14. A method according to claim 1, wherein each said second polygon is a triangle.

Sub A4

~~15. A method according to claim 1, wherein, in the step of defining a second polygon for a notional polygon, vertices for the second polygon are calculated in dependence upon the distance of the surface patch above each vertex of the notional polygon.~~

~~16. A method according to claim 15, wherein, in the step of defining a second polygon for a notional polygon, vertices for the second polygon are calculated by:~~

~~(i) calculating the distance of the surface patch~~

above each vertex of the notional polygon;

(ii) calculating a normal at each vertex of the notional polygon; and

(iii) for each vertex of the notional polygon, setting the position of a vertex for the second polygon at the point which lies a distance from the vertex of the notional polygon equal to the distance calculated in step (i) in the direction of the normal calculated in step (ii).

17. A method according to claim 16, wherein a forward differencing technique is used to calculate the distance of the surface patch above each vertex of each notional polygon.

18. A method according to claim 1, further comprising the step of filling gaps between the second polygons generated for rendering.

19. A method according to claim 18, wherein gaps are filled by moving vertices of second polygons generated for rendering.

20. A method according to claim 18, wherein gaps are filled by connecting vertices of second polygons to form

further polygons for rendering.

21. A method according to claim 18, wherein gaps to be filled are identified using a database defining, for each edge of each first polygon, the relationship between the normals at each vertex of the first polygons which share the edge.

Sub A5

22. A method according to claim 1, wherein the step of defining a surface patch is performed by processing data in object space, and the step of defining second polygons is performed in viewing space.

23. A method according to claim 1, further comprising the step of calculating lighting values for each second polygon by evaluating a polygon lighting equation for at least one of ambient, diffuse and specular light.

24. A method according to claim 23, wherein polygon lighting equations are evaluated to define a respective second surface patch for at least some of the first polygons, and lighting values are calculated for the second polygons thereof using the second surface patches.

Sub A6

25. A method according to claim 23, wherein, in the step

Cont A6

value for a vertex of a second polygon, the lighting value is calculated using the height of the second surface patch above the first polygon at the vertex of a notional polygon which corresponds to the vertex for which the lighting value is to be calculated.

28. A method according to claim 27, wherein a forward differencing technique is used to calculate the height of the second surface patch above each vertex of each notional polygon.

Sub A7

29. A method according to claim 1, further comprising the step of generating a signal conveying the second polygons.

30. A method according to claim 1, further comprising the step of producing rendered image data.

31. A method according to claim 30, further comprising the step of generating a signal conveying the rendered image data.

32. A method according to claim 31, further comprising the step of recording the signal.

into a plurality of notional polygons; and

a polygon definer for defining, for each notional polygon, a said second polygon for rendering using the surface patch of the corresponding first polygon to determine the positions of the vertices of the second polygon in three dimensions.

Cont A7

37. Apparatus according to claim 36, wherein the first polygons approximating the curved three-dimensional surface are triangular, and the patch definer is operable to define a Bernstein-Bezier triangular patch as the surface patch for each first polygon.

38. Apparatus according to claim 37, wherein the patch definer is operable to define a cubic Bernstein-Bezier triangular patch for each first polygon.

39. Apparatus according to claim 36, wherein the patch definer comprises a control value calculator for calculating control values at control points for the first polygon to define the surface patch.

40. Apparatus according to claim 39, wherein the patch definer is arranged to set the control values for each vertex of the first polygon to zero.

41. Apparatus according to claim 39, wherein the patch definer is arranged to calculate the control values for control points along an edge other than vertices by determining the distance from the control point of the tangent plane at the nearest vertex in a predetermined direction.

42. Apparatus according to claim 41, wherein the predetermined direction is based on the direction of the normal at the nearest vertex alone.

43. Apparatus according to claim 41, wherein the predetermined direction is based on the normal at each vertex defining the ends of the edge on which the control point lies.

44. Apparatus according to claim 36, wherein the patch definer is operable to define a Herron patch for each first polygon.

Sub A8

~~45. Apparatus according to claim 36, wherein the polygon divider is arranged to perform the division in dependence upon at least one of the size of the first polygon in a previous frame of image data, the size of the first polygon in the current frame of image data, the curvature~~

Cnl A8

of the first polygon, the distance of the first polygon from the viewing position in a previous frame of image data, and the distance of the first polygon from the viewing position in the current frame of image data.

46. Apparatus according to claim 36, wherein the polygon divider is arranged to divide each first polygon into the same number of notional polygons.

47. Apparatus according to claim 46, wherein the polygon divider is arranged to determine the number of notional polygons by testing each first polygon to determine a division number therefor defining a number of notional polygons, and selecting the highest division number.

48. Apparatus according to claim 46, operable such that:

processing is performed for each frame of image data to be generated to determine a level of subdivision defining the number of notional polygons into which each first polygon is to be divided;

data defining the second polygons produced for rendering is stored for future use when it is generated for a level of subdivision for which data is not already stored; and

the stored data is used when a frame of image data

is to be generated for a level of subdivision for which data is already stored.

49. Apparatus according to claim 36, wherein each said second polygon is a triangle.

Sub A9

50. Apparatus according to claim 36, wherein the polygon definer is arranged to calculate vertices for each second polygon in dependence upon the distance of the surface patch above each vertex of the notional polygon.

51. Apparatus according to claim 50, wherein the polygon definer comprises:

(i) a distance calculator for calculating the distance of the surface patch above each vertex of the notional polygon;

(ii) a normal calculator for calculating a normal at each vertex of the notional polygon; and

(iii) a vertex setter for setting, for each vertex of the notional polygon, the position of a vertex for the second polygon at the point which lies a distance from the vertex of the notional polygon equal to the distance calculated by the distance calculator in the direction of the normal calculated by the normal calculator.

Cont A9

52. Apparatus according to claim 51, wherein the distance calculator is arranged to calculate the distance using a forward differencing technique.

53. Apparatus according to claim 36, further comprising a gap filler for filling gaps between the second polygons generated for rendering.

54. Apparatus according to claim 53, wherein the gap filler is arranged to fill gaps by moving vertices of second polygons generated for rendering.

55. Apparatus according to claim 53, wherein the gap filler is arranged to fill gaps by connecting vertices of second polygons to form further polygons for rendering.

56. Apparatus according to claim 53, wherein the gap filler includes a gap identifier for identifying gaps to be filled using a database defining, for each edge of each first polygon, the relationship between the normals at each vertex of the first polygons which share the edge.

57. Apparatus according to claim 36, wherein the patch definer is arranged to define the surface patches by

processing data in object space, and the polygon definer is arranged to define the second polygons by performing processing in viewing space.

58. Apparatus according to claim 36, further comprising a lighting value calculator for calculating lighting values for each second polygon by evaluating a polygon lighting equation for at least one of ambient, diffuse and specular light.

59. Apparatus according to claim 58, wherein the lighting value calculator is arranged to evaluate polygon lighting equations to define a respective second surface patch for at least some of the first polygons, and to calculate lighting values for the second polygons thereof using the second surface patches.

60. Apparatus according to claim 58, wherein the lighting value calculator is arranged to determine the number of notional polygons into which each surface patch is divided, and:

(i) if the number of notional polygons is less than a predetermined number, to calculate a lighting value for each vertex of the second polygons by evaluating the lighting equation for each vertex; and

(ii) if the number of notional polygons is greater than a predetermined number, to calculate a respective second surface patch for each first polygon, and to calculate a lighting value for each vertex of the second polygons using the second surface patches.

61. Apparatus according to claim 59, wherein the lighting value calculator is arranged to calculate the second surface patch for a first polygon by:

(i) evaluating the lighting equation to calculate a lighting value at a plurality of control points for the first polygon; and

(ii) calculating values defining the second surface patch such that the surface patch interpolates the lighting values calculated at the control points.

62. Apparatus according to claim 59, wherein the lighting value calculator is arranged to perform processing to use a second surface patch to calculate a lighting value for a vertex of a second polygon by calculating the lighting value using the height of the second surface patch above the first polygon at the vertex of a notional polygon which corresponds to the vertex for which the lighting value is to be calculated.

63. Apparatus according to claim 62, wherein the lighting value calculator is arranged to use a forward differencing technique to calculate the height of the second surface patch above each vertex of each notional polygon.

64. Apparatus according to claim 36, further comprising an image renderer for producing rendered image data.

65. Apparatus according to claim 64, further comprising a display for displaying an image using the rendered image data.

Sub A10

66. Apparatus for generating polygons approximating at least a part of the surface of a three-dimensional object for use in rendering an image of the object, comprising:

a mesh generator for processing an initial polygonal model of the surface to generate a mesh of surface patches approximating the surface; and

a polygon model generator for generating a further polygonal model of the surface using the surface patches.

67. A storage device storing computer-useable instructions for causing a programmable processing apparatus to become configured to perform a method as set

out in at least one of claims 1 and 35.

68. A signal conveying computer-useable instructions for causing a programmable processing apparatus to become configured to perform a method as set out in at least one of claims 1 and 35.

69. A method of calculating light intensity values for a polygon in a computer model of a three-dimensional object, comprising:

(a) calculating a light intensity value at each of a plurality of control points for the polygon;

(b) defining a surface patch which interpolates the light intensity values calculated at the control points; and

(c) using the surface patch to calculate a light intensity value for each of a plurality of further points.

70. A method according to claim 69, wherein the polygon is a triangle, and a Bernstein-Bezier triangular patch is defined as the surface patch for the polygon.

71. A method according to claim 70, wherein a cubic Bernstein-Bezier triangular patch is defined as the

representation is a polygon.

Ent A14

138. Apparatus according to claim 127, wherein the representation is a parametric surface patch.

139. Apparatus according to claim 138, wherein the representation is a Bezier patch, and the polygon calculator is arranged to determine the area using the control points defining the corners thereof.

~~140~~ 98. Apparatus according to claim ~~127~~ 86, further comprising an image renderer for rendering the polygons to produce rendered image data.

~~141~~ 99. Apparatus according to claim ~~140~~ 98, further comprising a display for displaying an image using the rendered image data.

142. Apparatus for rendering a representation of an object surface, including:

a depth calculator for determining a depth of sub-division in dependence upon a size of the representation; and

a polygon generator for generating a plurality of polygons in dependence upon the determined depth.

143. Apparatus according to claim 142, wherein the size is the area of the representation.

~~144~~ 100. A storage device storing computer-useable instructions for causing a programmable processing apparatus to become configured to perform a method as set out in at least one of claims ~~107~~ 69 and ~~126~~ 86.

~~145~~ 101. A signal conveying computer-useable instructions for causing a programmable processing apparatus to become configured to perform a method as set out in at least one of claims ~~107~~ 69 and ~~126~~ 86.

146. A method of processing data defining a model of a three-dimensional curved object comprising a plurality of representations to generate data defining a plurality of polygons for rendering, the method comprising, for each frame of image data to be rendered:

determining a common depth defining the number of polygons into which each representation in the model is to be converted;

determining whether data defining the polygons for the common depth is already stored; and

if the data for the common depth is already stored, then selecting the stored data for rendering; otherwise

of calculating lighting values, the number of notional polygons into which each surface patch is divided is determined, and:

(i) if the number of notional polygons is less than a predetermined number, a lighting value is calculated for each vertex of the second polygons by evaluating the lighting equation for each vertex; and

(ii) if the number of notional polygons is greater than a predetermined number, a respective second surface patch is calculated for each first polygon, and a lighting value is calculated for each vertex of the second polygons using the second surface patches.

26. A method according to claim 24, wherein the step of calculating a second surface patch for a first polygon includes the steps of:

(i) evaluating the lighting equation to calculate a lighting value at a plurality of control points for the first polygon; and

(ii) calculating values defining the second surface patch such that the surface patch interpolates the lighting values calculated at the control points.

27. A method according to claim 24, wherein, in the step of using a second surface patch to calculate a lighting

33. A method according to claim 30, further comprising the step of displaying an image using the rendered image data.

34. A method according to claim 30, further comprising the step of making a recording of the image data either directly or indirectly.

35. A method of generating polygons approximating at least a part of the surface of a three-dimensional object for use in rendering an image of the object, in which:

an initial polygonal model of the surface is processed to generate a mesh of surface patches approximating the surface; and

a further polygonal model of the surface is generated using the surface patches.

36. Apparatus for processing data defining first polygons which approximate at least part of a curved three-dimensional surface to produce second polygons for use in rendering an image of the surface, comprising:

a patch definer for defining a respective surface patch for each first polygon to approximate the part of the object surface represented by the first polygon;

a polygon divider for dividing each first polygon

surface patch for the polygon.

72. A method according to claim 69, wherein a Herron patch is defined as the surface patch for the polygon.

73. A method according to claim 69, wherein, in the step of calculating a light intensity value at a control point, an intensity value is calculated by evaluating a lighting equation for at least one of ambient, diffuse and specular light.

74. A method according to claim 69, wherein the control points include the vertices of the polygon.

75. A method according to claim 69, wherein the further points for which light intensity values are calculated using the surface patch are the vertices of further polygons approximating the surface of the object.

76. A method according to claim 75, wherein at least some of the further points are within the polygon.

77. A method according to claim 69, wherein, in the step of using the surface patch to calculate a light intensity value at a further point, the intensity value is

calculated in dependence upon the height of the surface patch above the further point.

78. A method according to claim 77, wherein the intensity value is calculated as the height of the surface patch above the further point.

79. A method according to claim 69, wherein a forward differencing technique is used to calculate the light intensity values for further points.

80. A method according to claim 69, wherein steps (a), (b) and (c) are performed for each of a plurality of colour components to calculate respective light intensity values for each colour component.

81. A method according to claim 69, further comprising the step of generating a signal conveying the calculated light intensity values.

82. A method according to claim 69, further comprising the step of producing rendered image data.

83. A method according to claim 82, wherein, in producing the rendered image data, light intensity values

calculated for the further points are interpolated to produce light intensity values for other points.

84. A method according to claim 82, further comprising the step of generating a signal conveying the rendered image data.

85. A method according to claim 84, further comprising the step of recording the signal.

86. A method according to claim 82, further comprising the step of displaying an image using the rendered image data.

87. A method according to claim 82, further comprising the step of making a recording of the image data either directly or indirectly.

88. A method of calculating lighting values for a polygon in a model of a curved three-dimensional surface, in which a surface patch is calculated defining light intensity values for the polygon, and the surface patch is used to determine a plurality of light intensity values for interpolation.

89. Apparatus for calculating light intensity values for a polygon in a computer model of a three-dimensional object, comprising:

(a) a first intensity value calculator for calculating a light intensity value at each of a plurality of control points for the polygon;

(b) a surface patch definer for defining a surface patch which interpolates the light intensity values calculated at the control points; and

(c) a second intensity value calculator for using the surface patch to calculate a light intensity value for each of a plurality of further points.

90. Apparatus according to claim 89, wherein the polygon is a triangle, and the surface patch definer is operable to define a Bernstein-Bezier triangular patch as the surface patch for the polygon.

91. Apparatus according to claim 90, wherein the surface patch definer is operable to define a cubic Bernstein-Bezier triangular patch as the surface patch for the polygon.

92. Apparatus according to claim 89, wherein the surface patch definer is operable to define a Herron patch as the

surface patch for the polygon.

93. Apparatus according to claim 89, wherein the first intensity value calculator is operable to calculate an intensity value by evaluating a lighting equation for at least one of ambient, diffuse and specular light.

94. Apparatus according to claim 89, wherein the control points include the vertices of the polygon.

95. Apparatus according to claim 89, wherein the further points for which light intensity values are to be calculated using the surface patch are the vertices of further polygons approximating the surface of the object.

96. Apparatus according to claim 95, wherein at least some of the further points are within the polygon.

97. Apparatus according to claim 89, wherein the second intensity value calculator is operable to calculate an intensity value in dependence upon the height of the surface patch above the further point.

98. Apparatus according to claim 97, wherein the second intensity value calculator is operable to calculate the

intensity value as the height of the surface patch above the further point.

99. Apparatus according to claim 89, wherein the second intensity value calculator is operable to use a forward differencing technique to calculate the light intensity values for the further points.

100. Apparatus according to claim 89, wherein the first intensity value calculator, the surface patch definer and the second intensity value calculator are arranged to operate for each of a plurality of colour components to calculate respective light intensity values for each colour component.

101. Apparatus according to claim 89, further comprising an image renderer for producing rendered image data.

102. Apparatus according to claim 101, wherein the image renderer is arranged to interpolate the light intensity values calculated for the further points to produce light intensity values for other points.

103. Apparatus according to claim 101, further comprising a display for displaying an image using the rendered

image data.

104. Apparatus for calculating lighting values for a polygon in a model of a curved three-dimensional surface, comprising a surface patch calculator for calculating a surface patch defining light intensity values for the polygon, and an intensity calculator for using the surface patch to determine a plurality of light intensity values for interpolation.

105. A storage device storing computer-useable instructions for causing a programmable processing apparatus to become configured to perform a method as set out in at least one of claims 69 and 88.

106. A signal conveying computer-useable instructions for causing a programmable processing apparatus to become configured to perform a method as set out in at least one of claims 69 and 88.

~~107~~ 69. A computer graphics processing method, comprising:

receiving data defining a representation of a part of a curved three-dimensional object surface; and

dividing the representation into a plurality of polygons for rendering, wherein the number of polygons is

determined in dependence upon the area of the representation.

~~108~~ 70. A method according to claim ~~107~~ 69, wherein the number of polygons is determined in dependence upon the area of the representation in a previous frame of image data.

~~109~~ 71. A method according to claim ~~108~~ 70, wherein the number of polygons is determined in dependence upon the area of the representation in the frame of image data immediately preceding the frame for which the polygons are being generated for rendering.

~~110~~ 72. A method according to claim ~~108~~ 70, wherein the area of the representation is determined using the coordinates of vertices of polygons rendered in the previous frame of image data.

~~111~~ 73. A method according to claim ~~107~~ 69, wherein the number of polygons is determined in dependence upon the area of the representation in the frame of image data for which the polygons are being generated for rendering.

~~112~~ 74. A method according to claim ~~111~~ 73, wherein the area of the representation is determined by transforming points

defining the representation into the two-dimensional image coordinate system.

Sub A11

113. A method according to claim 111, wherein the area of the representation is determined by transforming a volume bounding a plurality of representations into the two-dimensional image coordinate system.

114. A method according to claim 107, wherein the area of the representation is determined as an average area of a plurality of representations.

Sub A12

115. A method according to claim 107, wherein the determined area is used as the input to a look-up table to generate a value indicating the number of polygons for rendering.

116. A method according to claim 107, wherein the number of polygons is determined in dependence upon the area of the representation and also the curvature of the representation.

117. A method according to claim 107, wherein the representation is a polygon.

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118. A method according to claim 107, wherein the representation is a parametric surface patch.

119. A method according to claim 118, wherein the representation is a Bezier patch, and the area is determined using the control points defining the corners thereof.

120. A method according to claim 107, further comprising the step of rendering the polygons to produce rendered image data.

121. A method according to claim 120, further comprising the step of generating a signal conveying the rendered image data.

122. A method according to claim 121, further comprising the step of recording the signal.

123. A method according to claim 120, further comprising the step of displaying an image using the rendered image data.

124. A method according to claim 120, further comprising the step of making a recording of the image data either

directly or indirectly.

125. A method of rendering a representation of an object surface, comprising:

determining a depth of sub-division in dependence upon a size of the representation; and

generating a plurality of polygons in dependence upon the determined depth.

126. A method according to claim 125, wherein the size is the area of the representation.

127. Computer graphics processing apparatus, comprising:

a receiver for receiving data defining a representation of a part of a curved three-dimensional object surface;

a polygon calculator for determining the number of polygons into which the representation is to be divided for rendering in dependence upon the area of the representation; and

a divider for dividing the representation into the calculated number of polygons for rendering.

128. Apparatus according to claim 127, wherein the polygon calculator is arranged to determine the number of

polygons in dependence upon the area of the representation in a previous frame of image data.

129. Apparatus according to claim 128, wherein the polygon calculator is arranged to determine the number of polygons in dependence upon the area of the representation in the frame of image data immediately preceding the frame for which the polygons are to be generated for rendering.

130. Apparatus according to claim 128, wherein the polygon calculator is arranged to determine the area of the representation using the coordinates of vertices of polygons rendered in the previous frame of image data.

131. Apparatus according to claim 127, wherein the polygon calculator is arranged to determine the number of polygons in dependence upon the area of the representation in the frame of image data for which the polygons are to be generated for rendering.

132. Apparatus according to claim 131, wherein the polygon calculator is arranged to determine the area of the representation by transforming points defining the representation into the two-dimensional image coordinate

system.

Cncl A13

133. Apparatus according to claim 131, wherein the polygon calculator is arranged to determine the area of the representation by transforming a volume bounding a plurality of representations into the two-dimensional image coordinate system.

134. Apparatus according to claim 127, wherein the polygon calculator is arranged to determine the area of the representation as an average area of a plurality of representations.

Sub A14

135. Apparatus according to claim 127, wherein the polygon calculator is arranged to use the determined area as the input to a look-up table to generate a value indicating the number of polygons for rendering.

136. Apparatus according to claim 127, wherein the polygon calculator is arranged to determine the number of polygons in dependence upon the area of the representation and also the curvature of the representation.

137. Apparatus according to claim 127, wherein the

generating data defining the polygons for the common depth, selecting the generated data for rendering, and storing the generated data for subsequent use.

147. A method according to claim 146, wherein, in the step of determining a common depth, each representation is tested to determine an individual depth therefor, and the individual depth defining the largest number of polygons is used as the common depth for all the representations.

148. A method according to claim 146, wherein, in the step of determining a common depth, a test on the model as a whole is performed to determine the common depth.

149. A method according to claim 146, wherein, the common depth is determined in dependence upon an area of each representation.

150. A method according to claim 149, wherein the area is the average area of all the representations.

151. A method according to claim 146, wherein the common depth is determined in dependence upon the curvature of each representation.

152. A method according to claim 146, wherein each representation is a polygon.

153. A method according to claim 146, wherein each representation is a parametric surface patch.

154. A method according to claim 146, further comprising the step of rendering the polygons to produce rendered image data.

155. A method according to claim 154, further comprising the step of generating a signal conveying the rendered image data.

156. A method according to claim 155, further comprising the step of recording the signal.

157. A method according to claim 154, further comprising the step of displaying an image using the rendered image data.

158. A method according to claim 154, further comprising the step of making a recording of the image data either directly or indirectly.

159. A method of rendering a three-dimensional computer graphics model, comprising:

receiving data defining a computer model of a three-dimensional object made up of a plurality of representations each of which models a respective part of the object; and

rendering each representation using the same number of polygons and such that data defining the polygons for different depths is stored and used in preference to calculating the polygons.

160. Apparatus for processing data defining a model of a three-dimensional curved object comprising a plurality of representations to generate data defining a plurality of polygons for rendering, comprising:

a depth calculator for determining a common depth defining the number of polygons into which each representation in the model is to be converted for a given frame of image data;

a data searcher for determining whether data defining the polygons for the common depth is already stored;

a first selector for selecting the stored data for rendering if the data for the common depth is already stored; and

a polygon data generator for generating data defining the polygons for the common depth, a second selector for selecting the data generated by the polygon data generator for rendering, and a data storer for storing the data generated by the polygon data generator for subsequent use if the data for the common depth is not already stored.

161. Apparatus according to claim 160, wherein, the depth calculator is operable to test each representation to determine an individual depth therefor, and to use the individual depth defining the largest number of polygons as the common depth for all the representations.

162. Apparatus according to claim 160, wherein, the depth calculator is operable to perform a test on the model as a whole to determine the common depth.

163. Apparatus according to claim 160, wherein the depth calculator is operable to determine the common depth in dependence upon an area of each representation.

164. Apparatus according to claim 163, wherein the area is the average area of all the representations.

165. Apparatus according to claim 160, wherein the depth calculator is operable to determine the common depth in dependence upon the curvature of each representation.

166. Apparatus according to claim 160, wherein each representation is a polygon.

167. Apparatus according to claim 160, wherein each representation is a parametric surface patch.

168. Apparatus according to claim 160, further comprising an image renderer for rendering the polygons to produce rendered image data.

169. Apparatus according to claim 168, further comprising a display for displaying an image using the rendered image data.

Sub A15

~~170. Apparatus for rendering a three-dimensional computer graphics model, comprising:~~

~~a receiver for receiving data defining a computer model of a three-dimensional object made up of a plurality of representations each of which models a respective part of the object; and~~

~~a renderer for rendering each representation, the~~

renderer being operable such that the same number of polygons are used to render each representation, and data defining the polygons for different depths is stored and used in preference to calculating the polygons.

171. A storage device storing computer-useable instructions for causing a programmable processing apparatus to become configured to perform a method as set out in at least one of claims 146 and 159.

172. A signal conveying computer-useable instructions for causing a programmable processing apparatus to become configured to perform a method as set out in at least one of claims 146 and 159.

Sub A16

~~173. Apparatus for processing data defining first polygons which approximate at least part of a curved three-dimensional surface to produce second polygons for use in rendering an image of the surface, comprising:~~

~~patch defining means for defining a respective surface patch for each first polygon to approximate the part of the object surface represented by the first polygon;~~

~~dividing means for dividing each first polygon into a plurality of notional polygons; and~~

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polygon defining means for defining, for each notional polygon, a said second polygon for rendering using the surface patch of the corresponding first polygon to determine the positions of the vertices of the second polygon in three dimensions.

174. Apparatus for generating polygons approximating at least a part of the surface of a three-dimensional object for use in rendering an image of the object, comprising:

means for processing an initial polygonal model of the surface to generate a mesh of surface patches approximating the surface; and

means for generating a further polygonal model of the surface using the surface patches.

175. Apparatus for calculating light intensity values for a polygon in a computer model of a three-dimensional object, comprising:

(a) means for calculating a light intensity value at each of a plurality of control points for the polygon;

(b) means for defining a surface patch which interpolates the light intensity values calculated at the control points; and

(c) means for using the surface patch to calculate a light intensity value for each of a plurality of

further points.

176. Apparatus for calculating lighting values for a polygon in a model of a curved three-dimensional surface, comprising means for calculating a surface patch defining light intensity values for the polygon, and means for using the surface patch to determine a plurality of light intensity values for interpolation.

~~177. Computer graphics processing apparatus, comprising:~~

~~means for receiving data defining a representation of a part of a curved three-dimensional object surface;~~

~~means for determining the number of polygons into which the representation is to be divided for rendering in dependence upon the area of the representation; and~~

~~means for dividing the representation into the calculated number of polygons for rendering.~~

178. Apparatus for rendering a representation of an object surface, including:

means for determining a depth of sub-division in dependence upon a size of the representation; and

means for generating a plurality of polygons in dependence upon the determined depth.

179. Apparatus for processing data defining a model of a three-dimensional curved object comprising a plurality of representations to generate data defining a plurality of polygons for rendering, comprising:

means for determining a common depth defining the number of polygons into which each representation in the model is to be converted for a given frame of image data;

means for determining whether data defining the polygons for the common depth is already stored;

means for selecting the stored data for rendering if the data for the common depth is already stored; and

means for generating data defining the polygons for the common depth, means for selecting the generated data for rendering, and means for storing the generated data for subsequent use if the data for the common depth is not already stored.

180. Apparatus for rendering a three-dimensional computer graphics model, comprising:

means for receiving data defining a computer model of a three-dimensional object made up of a plurality of representations each of which models a respective part of the object; and

means for rendering each representation, operable such that the same number of polygons are used to render

each representation, and data defining the polygons for different depths is stored and used in preference to calculating the polygons.